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AUTHOR Slaght, Ralph L.
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ABSTRACT

In 1982, the Alfred P. Sloan Foundation recognized that many of the graduates of the colleges and universities in this country were technologically and mathematically illiterate, and an attempt to begin to remedy this serious shortcoming was launched in their New Liberal Arts Program. Lafayette College in Pennsylvania was one of the 30 liberal arts colleges invited to submit proposals to the Sloan Foundation for funds to be used in remedying these deficiencies in their own student bodies. The need was for a technologically literate faculty which would breach the barricades of prejudice and remove the hostilities and misconceptions, for the mutual benefit of everyone, between the engineers and the humanities and social science faculty. Faculty seminars were the prime ingredient of the proposal, as well as conference support, released time for study, course development funds, computer education and software acquisition support, funds for the acquisition of library materials, guest lecturers, and--after the program was underway--diverted funds for a mathematics workshop for faculty. Necessary components for success in this enterprise were: (1) a supportive administration, one which encourages innovation and which provides flexibility in teaching assignments; (2) an intellectually alive faculty committed not only to excellence in their own disciplines but also to the meaningful liberal education of their students; (3) organized and committed program and seminar leaders; and (4) people with technical skills who can present their technical knowledge to others in a noncondescending and jargon-free way. (RAE)

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THINKING AND DOING: TECHNOLOGICAL LITERACY RECONSIDERED

by
Ralph L. Slaght
Lafayette College

[Prepared for presentation at the American Culture Association/Popular Culture Association Annual meeting in New Orleans, March 23, 1988.]

I owe my presence here today, I believe, to quirks of fate and so, I suspect, do many of you. But in another sense we all owe our presence here to technology. We are physically comfortable because of technology; our hunger has been satisfied by the fruits of technology; our thirst slaked by it. I dare say that not a single one of you sits here this morning stark naked. Who among you came upon a beast this morning, captured it barehanded, and devoured it, or a part thereof, for breakfast? How many of you made your way to the edge of Lake Pontchartrain or to the banks of the Mississippi River this morning for a drink and a bath? We all enjoy the fruits of technology, even if we are hill people in Nepal or jungle dwellers in Brazil. It's just a matter of degree.

What does the word "technology" mean? Many philosophers are quite fond of engaging in an enterprise called "conceptual analysis". What does a particular concept mean? What are the necessary and sufficient conditions for the appropriate application of a particular concept? The history of much of twentieth century Anglo–American philosophy is a history of the changing faces of this enterprise. Although I am perfectly capable of enrapturing you by presenting an analysis of the concept of technology, I will not do so. Nonetheless, we do need to share some common understanding of the notion if we are to avoid mere linguistic disputes later on. The etymology of the word would indicate that technology is the writings or study of arts and skills, but current usage seems to identify technology with the skill, its product, or the result of the study, rather than with the study of the skill itself. The same is true of other "–ologies" as the sentence "She used a lot of psychology on me to get me to speak today" indicates. The word "technology" is also often confused with "engineering", or with so–called "high technology". Both of these are too narrow. Technology is not just bridge–building, space exploration, and the like; it is also gardening and house–painting. It is not just integrated computer chips and the like; it is also needle and thread. These are arguable points, I know, but to argue them is not my purpose today. Suffice it to say that they represent my point of view.

There can be no society without technology. Where individuals share those tricks and skills which they have discovered in their attempt to ameliorate the harshness of nature, there one has a society. But those tricks and skills are just what I choose to call "technology". Without them, our lot, as Thomas Hobbes once wrote in another context, would be "solitary, poor, nasty, brutish, and short."(*Leviathan*, Chap. 18)

Technology is as fundamental to our existence as biology and it is certainly more fundamental than literature or economics. Yet how many institutions of liberal learning in this country, not to mention the rest of the world, have curricula that even pays lip service to technology? Not many, I dare say. How many of the academic programs of your own colleges and universities include courses in technology which are accessible to other than

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engineering students? My guess is: "Not many." Notice that I used the phrase "courses in technology" rather than "courses about technology." I see these as two different kinds of courses: one, where a particular bit of technology is taught, examined, and evaluated for both its technical and social impact; the other, where the technology is evaluated and sometimes examined, but never taught. Many such courses seem to be based on ignorance, where people learn to criticize without understanding. I fear such courses foster a dogmatic rather than an inquiring attitude. The criticisms produced in such an atmosphere tend to be ignored by the designers, manufacturers, or users of the criticized technology because it is usually said of those who criticize: "They just don't understand." Recently, I attended a conference dealing with the social and ethical impact of computer networking. The conference attendees were from both the business and the academic communities, with a wide spectrum of academic disciplines represented. Of course, philosophers were there, too, chiefly because of the ethical component of the program, and they had interesting things to say. However, the philosophers lost their credibility when it became clear during the discussion that few if any of them had ever used a computer network. Speaking from a conceptual understanding unmodified by experience, they made proposals which were impractical or impossible.

Let me say, as an aside, that although I applaud the teaching of such practical computer courses as word–processing, financial spread–sheet analysis, and statistical analysis, these kinds of courses are a far cry from what I have in mind. In fact, I am just a little worried about those courses in the social sciences which teach students how to use, say, SPSS or SAS, without a discussion of the relative merits and demerits of the particular type of analyses which those statistical packages provide, but that's another lecture. In as much as these how–to courses foster a more inquiring attitude towards the underlying, fundamental technology, they will be helpful in the achievement of my goals, but by themselves they will be far from sufficient.

One wonders why there is so much resistance to the teaching of technology in institutions of liberal learning. One wonders why there is such seeming antipathy between the Arts Faculty and the Engineering Faculty at institutions which have both. Here are two answers, one from this end of the twentieth century by an engineer and the other from the other end of this century by a philosopher. James Adams, an engineer currently of Stanford University, writes in an (in so far as I know) unpublished essay simply named "Sloan Essay":

> There are several reasons. Some of them become clear from thinking a bit about the origins of the liberal arts. Credit for parentage is often given to the Greek academies. In ancient Greece, education in matters of politics and war were available to leaders, but in rather informal tutorial formats. However, during the intellectual ferment of the Hellenistic period, educational institutions were established specifically to provide formal education to citizens and future leaders. The most influential of these were the academies (Plato's academy, Aristotle's Lyceum, the Gardens of Epicurus, Zeno's stoa). These were highly influential for many years (Plato's academy was finally closed in 529 A.D. by Justinian because its faculty refused to become Christian). They were probably the first "liberal arts" institutions of higher learning and still to some extent serve as a pattern. It should be noted that in Hellenistic Greece, citizens were in the minority. Such "lesser" forms of life as foreigners, slaves, and businessmen did what we would consider "the work" and did not hold citizenship. The founders, staff, and

> students of the academies were disdainful of physical labor, trade, and technology, since citizens were supposed to be above such activities. They were rather concerned with topics such as politics, athletics, and war and valued pure philosophical pursuits. (page 4)

The other response comes from a man who was a life–long champion of personal growth and development by means of education. One of the chief articulators of that uniquely American philosophical movement, pragmatism, John Dewey was a champion of democracy and of personal growth through continuous self–education. In his book, *The Quest for Certainty*, he wrote:

> The depreciation of action, of doing and making, has been cultivated by philosophers. But while philosophers have perpetuated the derogation by formulating and justifying it, they did not originate it. They glorified their own office without doubt in placing theory so much above practice. But independently of their attitude, many things conspired to the same effect. Work has been onerous, toilsome, associated with a primeval curse. It has been done under compulsion and the pressure of necessity, while intellectual activity is associated with leisure. On account of the unpleasantness of practical activity, as much of it as possible has been put upon slaves and serfs. Thus the social dishonor in which this class was held was extended to the work they do. There is also the age–long association of knowing and thinking with immaterial and spiritual principles, and of the arts, of all practical activity in doing and making, with matter. For work is done with the body, by means of mechanical appliances and is directed upon material things. The disrepute which has attended the thought of material things in comparison with immaterial thought has been transferred to everything associated with practice. (pages 4–5)

Nowhere is this disdain for activity, for soiling one's hands in labor, more evident to me than in India. I had the opportunity to spend nine months in South Asia a few years ago. Most of my time there was spent on the beautiful and arboreous campus of one of India's most prestigious institutes of technical education, the Indian Institute of Technology at Madras. Even at such an institute of technology, there was a disdain for soiling one's hands with the practical affairs of life. My family and I were occupying a flat on the campus which, unlike most of the rest of the flats, had been equipped with a hot–water heater (a previous softy from some non–Asian country had insisted on its installation). However, the water heater did not work. In attempting to repair the device myself, I discovered that I needed a wrench (a spanner, they called it). Now, one does not normally travel with a toolkit containing wrenches, so I asked my neighbors if they had one which I might borrow. No–one nearby had one, but one of my neighbors said to me, "But why would you want to fix it yourself? We have people who do that sort of work!" There were many students at IIT, Madras who were interested in computer science. They had taken numerous courses in computer science theory and programming. But almost none of them had ever touched a computer terminal keyboard. Of course, there were few such things available, but no–one seemed particularly distressed by this lack of practical experience. Theory, after all, was so much more important.

After I had returned to Lafayette College from India, I was invited to be the required international reader of a Ph.D. dissertation being written at IIT, Madras. I accepted and in due course a copy of the dissertation arrived. The author was proposing to blend techniques

of business administration with computer technology to produce a computer program, called an expert system, which could be used to make, or assist a business executive in making, important business decisions. An elaborate system of rules were presented. along with a description of how the computer would make use of the rules. In my response to the committee which was supervising the candidate's work I remarked that the proposal was certainly very interesting, but no evidence had been presented which might lead one to believe that it might actually work. "Had the program been put on a computer and tested in a simulated business environment?", I asked. The director of the candidate's work responded that I was being rather unrealistic to expect that the proposal would actually be tested! "After all", he implied, "it seems theoretically sound. What more could one ask of a Ph.D. candidate?!"

The separation of the intellectual from the practical, the mental from the physical, is aided and abetted by the caste structure of Indian society, a structure likely to remain in place for many, many years. In our country, a casteless and classless society, the separation is much less pronounced, but I do believe that it exists, nonetheless, and it is being preserved in the American academies of higher learning. But I submit to you that such vestiges of Platonic elitism, of slave and serf meniality, of Calvanistic castism, of mi–lord and mi–lady's classism, have no place any longer in higher education anywhere in the world, and especially here in the United States of America, the land of the free. Liberal Arts, the course of study befitting a free person, can no longer be limited to those in the quest for Certainty, to those who equate clean hands with a pure heart. The cause of freedom demands a new liberal arts, not the studies which befit a free person, but the studies which are truly liberating, studies which remove the shackles of ignorance. Recalling the remark by Francis Bacon made so many years ago –– "Knowledge is power."–– I believe that to the extent which I fail to understand those factors which control my life, I am controlled by those who do. In the earlier days of our country when so many of the citizens were farmers, the teaching of technology in institutions of education was not so important; so much was taught at home and at work. Local and national political issues of a technological nature were understandable by the voters. Dams, bridges, agricultural policies, building codes, hand guns and rifles–– these were familiar to many. But the industrialization of America brought new technologies unfamiliar to the populace, resulting in laws and regulations which were ineffective in dealing with the changing conditions. Only recently have we as a nation begun to understand and appreciate that disaster. Silicosis and Black Lung disease in our miners, the pollution of our lakes and rivers, the contamination of our drinking water, the fouling of the very air we breathe––these are processes which many of our voters and some of our legislators still do not fully understand. And to say this is to say nothing of the technologically more sophisticated issues of nuclear energy, exploration of outer space, exploitation of sea–bed minerals, the computerization of our society, military weaponry, and the Strategic Defense Initiative. We can not possibly hope to deal with these issues in any intelligent way if we do not understand them. We are forced to defer to the expert or the pseudo–expert and in so deferring, we abdicate some of our freedom. In fact, around 1932 there arose a political movement called the Technocracy Movement which blended what some might call radical economic theory with the belief that our society had become too complicated to be run by mere politicians. Instead, the Technocratists advocated a government populated with scientists and engineers. 1934 was the high point of the movement and today, according to my historian of technology colleague, Professor Charles Best, it is all but dead.

In 1982 the Alfred P. Sloan Foundation recognized that many of the graduates of the

colleges and universities in this country were technologically and mathematically illiterate. In an attempt to begin to remedy this serious shortcoming, a shortcoming about which I hope I have now convinced you, they launched their New Liberal Arts Program. The Foundation invited 30 Liberal Arts colleges to submit proposals to the Sloan Foundation for funds to be used in remedying these deficiencies in their own student bodies. Those schools who accepted the invitation were given funds to cover the cost of preparing the proposal. The schools were told that ten of their proposals would be accepted and funded for a three–year period in an amount not exceeding $250,000. Lafayette College was invited to apply. The President invited faculty who he thought might be interested to his home one balmy late spring evening to discuss the offer and to formulate a response. There were about 20 of us there, representing many academic disciplines, including engineering (Lafayette College, for those of you unfamiliar with us, is a college of Arts, Sciences, and Engineering). Many were enthusiastic; many were skeptical. After all, some of us had recalled an earlier rather unsuccessful effort of the Sloan Foundation to bring the Social Sciences together with Engineering. Nonetheless, the enthusiastic optimists won out, a positive response to the Foundation was urged, and a plan for preparing a proposal was formulated. The President invited five of us to constitute the proposal writing team. Our team consisted of two engineers, a professor of English Literature and American Civilization, an anthropologist, and a philosopher who was also a former director of the Academic Computer Center on the campus. We met daily, or so it seemed, during the early part of the summer, arguing, educating, debating, and then we went our separate ways for a time while one of us prepared a tentative proposal.

During that time of intense discussion we made several fundamentally important decisions. First, we decided that what the Sloan Foundation was asking us to do was revolutionary, that no mere addition of "cute" courses to the curriculum would do the job, that to produce technologically literate students required a technologically literate faculty or at the very least, a faculty which was not hostile to the effort, and that therefore, our primary focus would not be the students, but the faculty instead. The second significant decision was to urge the President to proceed with the program whether or not we were funded by the Sloan Foundation. We recognized that to proceed without funding would involve more modest program components than we had asked for and that the implementation time would have to be spread out over several additional years. Nonetheless, we felt very strongly that after many, many years of some of us sneering back and forth at each other across the campus – the engineers on the northwest side, the humanities and social science faculty on the southeast side – we had within our reach the means to breach the barricades of prejudice, to remove the hostilities and misconceptions, for the mutual benefit of everyone.

Some of us hoped that one of the results of our efforts would be a bachelor of arts curriculum more in keeping with the character of the college than the one we current had (and still have). Lafayette, along with many other institutions of higher learning, discarded its structured curriculum in 1970, replacing it with a set of recommended areas of study. A compromise at best, we struggled with it until the Fall of 1980 when what we have described as a "goals–oriented" bachelor of arts curriculum was put in place. Those goals are: English Competence, Understanding of Symbolic and Quantitative Reasoning, Knowledge of a Foreign Culture, Understanding of Scientific Inquiry, Understanding of Humanistic Inquiry, and an Appreciation of Artistic Expression. Clearly missing from this list, for a college of Arts, Sciences, and Engineering, is a goal pertaining to technology. But it was not possible, politically, to insert such a goal into the program. An earlier report from the Curriculum

Committee had at least mentioned technology [March 21, 1978], but that report was gradually amended to death and the final vote on the much–amended motion which would have implemented the report was overwhelmingly defeated by the Faculty. So there we were in 1982, expecting, indeed requiring of our bachelor of science students, that they take humanities and social science courses, but not even urging as a Faculty that our bachelor of arts students attempt to gain an understanding of technology. Hence it was that one of the unstated goals of our local Sloan leadership was to alter the perceptions and attitudes of the faculty in such a way that a goal of understanding technology might be made an integral part of our bachelor of arts curriculum. Our stated goal was a technologically literate faculty who would integrate the teaching of some aspect of technology into their courses in such a way that students graduating from Lafayette would themselves be technologically literate without their having to take some particular course or other specifically tailored to that purpose. To achieve this goal we proposed to hold a series of Faculty seminars.

The Faculty seminars were the prime ingredient of our proposal. Of course, there were other ingredients, too: conference support, released time for study, course development funds, computer education and software acquisition support, funds for the acquisition of library materials, guest lecturers, and after the program was underway, we diverted funds to a mathematics workshop for faculty. The proposal was submitted and we immediately, with the support of the President, proceeded to implement portions of the plan, hoping for funds from Sloan, but determined to carry on even without them.

To facilitate the management of the program, the President attempted to appoint a single director, but due to previously–planned sabbatical leaves, he was unable to get the person he wanted for the full three years of the grant life, so he appointed a trio of us, the one who had no leave planned was to handle the finances, the other two were to do the rest. The troika, as we sometimes called ourselves, consisted of a professor of English Literature and American Civilization, a philosopher, and an engineer. While we were organizing the first seminar, word came that we had been one of the lucky ten schools.

The Seminars were designed to have twelve participants, including two leaders. Participation was by invitation of the directorate. We considered a number of criteria in extending our invitations. First, we needed to have a few members of each seminar who possessed technical knowledge and skills, so we invited a couple of engineers to join. Secondly, since we wanted continuity among seminars, we wanted to have one or two people from one seminar become leaders of another. Thirdly, since we needed the support, if not the acquiescence, of the faculty leadership, we invited department heads and members of the appointments, promotions, and dismissals committee. Fourth, since we sought to eliminate campus hostility to technology, we invited those who were known to be hostile. Finally, we sought a disciplinary mix. After a list of potential participants was drawn up with these criteria in mind, personal visits were made to each one and invitations were extended. Although we were not always successful in enticing our target, we did have a very high rate of affirmative responses.

The Seminars were designed to meet for an intensive period of two weeks during either the winter vacation or following the end of classes in early June. To develop materials and plans for those two weeks, the seminars were also scheduled to meet at least once a month during the semester. We gave a stipend to each participant ($1000 each for those who participated sometime during the first year and half of the program, $1200 for those who participated during the second half). We purchased relevant books for the members of each

seminar and offered those books to members of previous seminars too. We had a concluding banquet for each seminar, as well as an occasional lunch with visiting speakers. Where appropriate, there were field trips. We asked the participants to determine the responses of their respective disciplines to technology and to consider ways of introducing the teaching of some aspect of technology into their courses. Initially, each seminar was to determine for itself its subject matter and methods of procedure, but the unstructuredness of this approach resulted in countless hours of rambling discourse and directionless dialogue. What we finally adopted were seminars with a focus planned by the leaders who had been selected before the rest of the seminar membership had been selected. The topics selected by the various leaders of our last four seminars were bridge–building, artificial intelligence, water management and waste disposal, and gothic cathedrals. Of the three seminars which began without a specific focus, two of them eventually spent considerable time confronting the computer.

During those planning meetings which took place during the semester, discussions of educational philosophies and methodologies took place, as well as presentations and discussions of technical aspects of the chosen topic. The participants gradually came to realize that engineers and humanists were not all that different when it came to teaching, that they shared many of the same problems, that they had found many of the same solutions, and that the only significant difference between them was their respective subject matter. The liberal arts faculty came to see the engineers as thoughtful people who shared with them many of the concerns about technology which the liberal arts people thought that they alone had held. On the other hand, the engineers developed a more thorough understanding and respect for the concerns of the humanists. We didn't win the hearts and minds of every participant, but in total, the seminars have been highly successful.

The intensive two–week period varied from seminar to seminar. Some built scale–model bridges, performed stress tests on various materials, others engaged in research on technologies which had had a significant impact on some aspect of their discipline. Some used the computer to do structural analysis of buildings. One seminar group wrote an expert system (an applied artificial intelligence computer program) to aid in the selection of a used car. And two seminars studied computer programming. My seminar asked me to teach them a bit about writing computer programs using the Pascal programming language. I found it to be a very interesting challenge to develop non–numerical teaching materials which would be of use and interest to people in art, languages, and English, as well as to the mathematicians and engineers in the group. It was during the first session at an actual computer terminal that I uncovered a true case of computer phobia, the one described in the March '86 issue of *CHANGE* magazine, but by the end of the two weeks he and I had overcome his fear. [Incidentally, the phobic faculty member is now an owner and user of the microcomputer.] I also discovered, as did some of my humanistic colleagues, that some engineers were as uncomfortable with the computer as they were. It was most interesting to hear an engineer confess that he never used a computer terminal in a public area because he felt so unsure of himself!

Permit me to digress for a moment to talk about what I actually did when teaching my colleagues about Pascal programming. First, it should be made clear that I was not attempting to produce Pascal programmers. The idea was to get them started, to introduce them to the technology, not make them proficient. We had to begin at the very beginning: how to turn on the terminal, how to log onto the campus computer system, how to use the text and programming editor on the system. It was only after all of this that we

could begin to deal with Pascal. I used as a text one of the volumes from the series, "The Secret Guide to Computers" by Russ Walter. The "Guide", an eight volume series, is irreverent, humorous, and very accessible to beginners; and I recommend them highly. Instead of learning how to manipulate numbers, we learned to manipulate those things which most of us in the humanities spend so much of our time manipulating, viz., words. Eventually, we wrote a little program for sorting lists of names. I always used words from their vocabulary, eschewing computer jargon as much as possible and I constantly looked for ways to show them how the computer could be useful to them in their work. But I digress too much. Let me return to our Sloan program---

In an attempt to begin to gauge the success of our seminars we asked each seminar participant to put in writing an evaluation of his or her experience in the light of the goals I outlined above. Evaluations from the early seminars exhibited early frustration with the seminar's having to find its own path, but almost everyone felt that the experience had been well worth the time and effort. In many of the evaluations we found evidence of success, but as an indication of the depth of the division between the technologists and the humanists, I thought that the following two evaluation would be of interest to you.

In evaluating his seminar experience, a colleague wrote:

> "The single, general impression which affected me most was not the technological ignorance of my colleagues in the social sciences and humanities, but rather the humanistic ignorance of my colleagues in the natural and applied sciences. If "Sloaning" taught me anything, it taught me that humanists and social scientists have failed in making what they do and what they know to be important sufficiently available to their colleagues in the natural and applied sciences."

Equally revealing is a quote from the evaluation report of one of his fellow seminarians:

> "At one point during our intense two-week period, one of the two "leaders" commented that the seminars could infuse "humanities" into the sciences and engineering. Of course such seminars would indeed be a genuine exchange. There's nothing wrong with the idea, although that was not the original intent. I find, however, that such a thought rests upon a very faulty premise: that science and engineering faculty know nothing outside their disciplines. During the course of Sloan VI, there was little in the way of philosophical, social, and legal ideas and thought that I had not heard before. I have read much of Camus, Nietszche, Aristotle, Plato...I do not mean to sound arrogant or condescending; but, small college science and engineering faculty are not typical "technologists"."

These two quotes are evidence of failure, not success and I have read them to you not out of some perverted desire to exhibit our inadequacies, but rather to show the kind of campus hostility we have had to face. These two quotes are clear evidence that we didn't win the hearts and minds of all of our targets.

The seminars themselves have been a wonderful experience, so report the seminarians. Whether we have made significant progress towards all of our goals remains to be seen, but there is no doubt that we have demolished the wall I referred to earlier. Oh, there may be a few remaining piles of rubble out there, as the two earlier quotes reveal, but I believe that the wall is gone. What we now need to do is to build on this success, to turn technological receptivity into curricular change. Phase two, supported by a renewal grant from the Sloan Foundation, is designed to accomplish this. In fact, some of this curricular change has already begun. Because of interests piqued in one or another of our seminars, some faculty

have developed courses or course components around various technologies. Interdisciplinary courses on such topics as health care in a technological society, the science and politics of nuclear energy, and what to do with hazardous and toxic materials have been developed and taught by teams of two or three professors. Engineers and humanists meet on common ground in programs on cathedral construction, electronic art, and the physics of music. The dot–matrix printer as well as the printing press are compared and contrasted. The engineering of the systems of Incan Indian canals is examined in some detail. Syllabi and related materials for our Sloan–related courses, as well as similar materials from the other participating colleges in the New Liberal Arts Program of the Sloan Foundation may be obtained from John Truxal, Department of Technology and Society, SUNY at Stony Brook (New York 11794–2250; phone: 516 632 8760).

The other nine colleges initially selected by Sloan to receive grants of $250,000 were Carleton, Davidson, Grinnell, Mount Holyoke, Oberlin, Vassar, Wellesley, Williams, and Union College in New York. Since that first round of grants, others have been added to the list but I think that it is fair to say that each one of these schools has approached the Sloan challenge in ways uniquely suited to their own campus situation. We at Lafayette were blessed with cooperative engineers on our Faculty. Other schools were not so fortunate; not that their engineers were uncooperative, but that they did not have engineers at all. Some schools chose to concentrate on the development of special courses, courses designed by a interdisciplinary team of faculty. Other schools concentrated on the mathematical component of the New Liberal Arts Program. Still others emphasized the computer. The five independent colleges of Claremont, California, have an interesting program which has been funded in the second round of funding by the Sloan Foundation. Building on the experience and success of a program of engineering clinics given in the engineering and science college, Harvey Mudd, the Claremont program is emphasizing a program of technology clinics, where a team of four to six students and several faculty confront a technological challenge posed to them by some local industry or agency. For a fee which goes to support the program, the company interacts with the group in the common pursuit of a genuine, real–world problem. Professional quality results are expected and are delivered. The first clinic was concerned with the questions surrounding the insurance reimbursements of balloon angioplastic procedures. The second clinic is investigating for the Jet Propulsion Laboratory the problem of how to improve the effectiveness of the robot arm of the Space Shuttle when it is used to reach around one object to get at the another object behind the first one or to work on the far side of an object. The Claremont program has just begun and so its long–term success is uncertain. However, they have had a very exciting beginning and if the 25 year longevity of the engineering clinics can be used a predictor of success, then the technology clinics will be around for some time to come. We at Lafayette decided that the Claremont clinics were adaptable to our own setting and the first clinic is now nearing completion, having tackled the problem of how to deal with the floating debris which backs up behind many of the hydroelectric dams on the Susquehanna River.

I can offer you no formula for success in this enterprise, but I do believe that the following conditions are necessary: a supportive administration, one which encourages innovation and which provides flexibility in teaching assignments; an intellectually–alive faculty committed not only to excellence in their own disciplines but also to the meaningful liberal education of their students; organized and committed program and seminar leaders; and finally, people with technical skills who can present their technical knowledge to others in a noncondescending and jargon–free way. What else is needed depends on local conditions. Money is not necessary. Melding technology into liberal arts education is really

more a matter of attitude than of finance. Of course, the challenge is monumental; we face 2000 years of cultural and philosophical biases, but succeed we must. What is at stake is our very way of life. Are we to become a technocracy with technologists as masters and the rest of us as "techno–peasants" or will democracy endure?

Note: I am indebted to Professor John Brockway of Davidson College for the term "techno–peasant."